SAR high resolution image sub-pixel correlation for landslide monitoring. Application to Salazie (La Reunion Island) and La Valette (Alps) landslides

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SAR HIGH RESOLUTION IMAGE SUB-PIXEL CORRELATION FOR LANDSLIDE MONITORING. APPLICATION TO SALAZIE (LA REUNION ISLAND) AND LA VALETTE (ALPS) LANDSLIDES.

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In this study we propose the use of the radar amplitude data to construct ascending and descending correlograms following the sub-pixel correlation technique. This technique has been widely used to map surface deformation based on optical data (e.g. [1]), as optical sensors provided better resolution than SAR sensors in the last decades. SAR data were therefore more adapted to retrieve large ground surface deformations such as co-seismic (metric) surface displacements (e.g. [2]). Concerning landslide displacement mapping, before the advent of high spatial resolution SAR imagery, the use of the correlation techniques based on SAR data was limited by the multi-metric spatial resolution of the previous generation of space-borne SAR sensors (e.g. EnviSAT/ASAR or RadarSAT 1). The spatial resolution of those SAR data put a limit on the precision of the results and hampers the possibility of covering small size landslides. Therefore, the radar amplitude correlation technique was suitable only for specific cases of landslide with important displacements over large areas.

Today, with the recent launchs of TerraSAR-X and Cosmo-Skymed missions offering sub-metric spatial resolutions, the situation has changed and the characteristics of the radar images in terms of resolution are equivalent to those provided by optical high resolution sensors widely used for image correlation (such as Spot 5, Quickbird, etc.). In this context, the SAR data is becoming an interesting alternative to optical data for image correlation techniques applied to ground surface deformation.

The presented observations result of the application of sub-pixel image correlation to Landslides located in the “Cirque de Salazie” in La Réunion Island where the cloud cover could be a limitation for optical data ([3]) and on the La Valette (French Alps) Landslide. These rather large (size ~ 1-2 km) landslides have different characteristics in terms of displacement regime: about 50 cm/yr for the Hellbourg landslide (Salazie) and up to tens of m/yr for la Valette.

We base our study on temporal series of Cosmo-Skymed and TerraSAR-X High Resolution SAR images in order to assess the annual evolution of surface displacements due to landsliding (figure 1

shows the resulting displacement map obtained using data acquired in descending mode on la Valette Landslide).

The combination of ascending and descending displacement maps (projections of the displacement on 4 different directions) will allow providing a 3D description of the studied phenomenon (by applying the method proposed in [2]). Conversely to other kind of phenomena (e.g. subsidence), the 3 components of the displacement are needed to correctly describe a landslide displacement that can have much complex characteristics.

Finally, the ability of the spaceborne SAR sensors to generate reliable temporal series of acquisitions will allow deriving the evolution of the motion and in particular identifying accelerations that could provide useful information in terms of phenomenon monitoring and risk mitigation. Techniques used in SAR interferometry (such proposed in [4]) will be adapted to derive deformation Time Series from the correlation results.

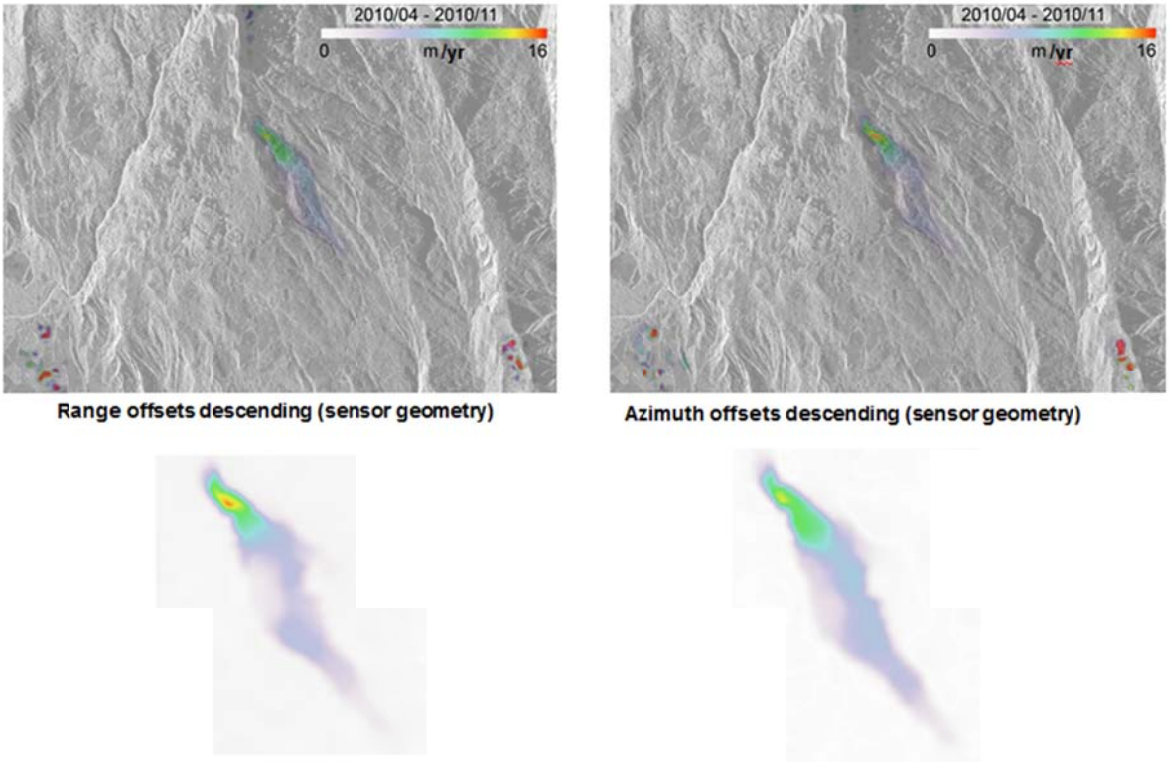

Figure 1: Annual displacement on la Valette landslide estimated on the period April 2010 – November 2011 based on a series of 12 High Resolution Spot Light TerraSAR-X images acquired in descending mode. Left: Line of Sight displacements; Right: Azimuth displacements. High resolution provides a detailed representation of the displacement: in particular, sectors with the different displacement rates can be clearly identified.

2. REFERENCES

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